

GLAST EDUCATION AND PUBLIC OUTREACH PROGRAM

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We outline here the Education & Public Outreach (E/PO) program that accompanies the GLAST Instrument development in the pre-launch years 2001-2006. Gamma-ray astronomy is an exciting field for the public as well as the researcher. Both young and old can be engaged by the exotic concepts of black holes and violent explosions seen across the Universe. Thus, we believe that the GLAST E/PO program is well suited to promote inquiry into the origin and structure of the Universe and the fundamental relationship between energy and matter, concepts which are included in the National Science Content Standards A, B, & D for grades 9-12.

In the GLAST E/PO program, we therefore focus on the following specific educational goal:

We will utilize the observations and scientific discoveries of the GLAST mission to improve the understanding and utilization of physical science and mathematics concepts for grades 9-12.

The flow down of GLAST E/PO goals from the specific science goals for GLAST is shown in Table 1. The alignment of GLAST E/PO goals with the program components and the overall goals of the NASA Science Mission Directorate's Universe Division is also shown in this Table.

1. GLAST Mission E/PO Program Components

1.1 Web-based Curriculum Materials: Space Mysteries and GLAST Website

Under a previous grant through the NASA LEARNERS program, the SSU team developed a series of three inquiry-driven interactive Web explorations that take advantage of a person's natural curiosity to build critical thinking and analytical skills. Each mystery is constructed to teach at least one of the important science standards for Grades 9 – 12 and to support a wide range of NCTM Standards 2000 requirements. Additional materials for use by classroom teachers accompany the online modules. Essential parts of each mystery are video interviews with scientists. The LEARNERS-funded work forms the basis of this GLAST program component and has allowed us to do front-end assessment for the GLAST E/PO program during 2000-2003. We are developing two additional modules during 2004-2006: Galactic Doom and Solar Supernova. For further information about Space Mysteries, see: <http://mystery.sonoma.edu>.

SSU team members also maintain and expand the GLAST outreach website (<http://glast.sonoma.edu>), so that all formal GLAST E/PO materials are available for download from one place (<http://glast.sonoma.edu/teachers/teachers.html>). Materials may also be ordered through this web page. The site also includes descriptions of the instruments, GLAST science, the gamma-ray Universe, an image gallery, a multi-media section, Ask-a-GLAST-scientist, profiles of the GLAST Interdisciplinary Scientists and the GLAST Educator Ambassadors, and links to online and downloadable versions of all GLAST E/PO presentations. The site is regularly checked for compliance with Federal Code 508 (disability access) and meets all Code 508 regulations.

1.2 TOPS Formal Education materials and other printed materials

TOPS Learning Systems, a non-profit education organization dedicated to the development of low-cost, hands-on materials as part of a comprehensive math/science program, is developing printed classroom materials for GLAST. During 2002-2006, TOPS Learning Systems is creating 3 curriculum modules. Two have been released to date: *Far Out Math* (2003) and *Scale the Universe* (2005), and the third is being technically and formatively evaluated in June 2005 (*Thumbs Up: A Geometry of Space*) for release by 2006. TOPS modules are famous for involving students in an inquiry-based study of science using simple, inexpensive materials, many of which are already available in the classroom. TOPS lessons plug directly into the scope and sequence of the National Education Standards, and lessons developed for GLAST will emphasize the Physical Sciences Content Standards A, B & D for grades 9-12 and mathematics standards for grades 9-12. TOPS has their own field-testing and evaluation procedures that they will use in the initial development of the modules and teacher's guides. SSU staff provide initial concept reviews, then technical and pedagogical review, and well as in house testing. The materials are then revised after further evaluation by the Educator Ambassadors (see 1.3) and independent assessment by WestEd (see Section 2).

SSU also creates classroom posters and manipulatives that aid educators in presenting the science and mathematics content of GLAST-oriented activities. We have released the Active Galaxies Educator guide and wallsheet, which were extensively tested and reviewed by the Educator Ambassadors, as well as by WestEd and the NASA SMD educational review process. A second Educator Guide featuring supernovae is currently under development, co-sponsored by the XMM-Newton E/PO program. Prior to launch, we expect to produce a GLAST Model booklet, and other supporting materials including a litho and a fact sheet. Still in negotiation is a possible educator workshop at launch.

We also routinely create informal printed materials of interest to the project, such as brochures for the public and educationally-oriented "giveaways" such as the GLAST Magic Cube, the forthcoming Active Galaxies "pop-up" book for younger children, and the GLAST Race card game.

1.3 Educator Training: GLAST Educator Ambassadors and other Teacher Training Workshops

We have created a program of 10 educators (for detailed profiles, see <http://glast.sonoma.edu/ambassadors/ambassadors.html>), who work in conjunction with GLAST science and E/PO team members at SSU and SLAC to develop workshops and curriculum materials. These educators have been selected via a nation-wide application process and have become "GLAST Educator Ambassadors" for the entire program lifetime (annually renewable depending on performance and continued interest). Part of the selection process includes not only the qualifications of the candidates, but their plans to disseminate GLAST materials and information in their local, state, and regional areas. In addition, particular attention has been paid to applicants with special abilities to reach underserved communities. These educators, whether formal or informal, come to both SSU and SLAC for bi-annual training. In the interim, additional training occurs via learning-at-a-distance modules set up on the Internet by the E/PO team. (http://epo.sonoma.edu/eas_lad/index.html). Each GLAST Educator Ambassador (EA) is required to have his or her own plans (via teacher in-services, public lectures, museum programs, educator conferences, etc.) to routinely disseminate GLAST materials throughout the year and is required to perform at least four approved dissemination activities yearly. Recent reports for

2004 indicate that each EA actually gave an average of eight teacher workshops, for a total of 80 workshops reaching 5934 teachers directly. The GLAST EAs will also attend the launch of the GLAST satellite, so that they may convey that experience to their fellow educators and to their students. Finally, this cadre of educators serves to field-test any and all materials that the GLAST E/PO team creates and provides crucial, formative feedback in the ongoing development of the materials. All 10 GLAST EAs attended the most recent training session that took place in July 2004 (see the presentations online at <http://epo.sonoma.edu/ambassadors/training04/index.html>) The next EA training will be held at Sonoma State University in July of 2006.

GLAST E/PO team members and EAs interact with and disseminate GLAST curricular materials via workshops and conferences at the national, state, and local levels. Such interactions allow for direct feedback on the quality and effectiveness of the GLAST materials and programs, as well as affording a high-leverage opportunity to teach additional teachers to use GLAST materials in their classrooms. Workshops at national and regional conferences are routinely evaluated by WestEd.

In addition to presenting workshops, GLAST science team and E/PO staff exhibit booths at education (e.g. CSTA) and scientific conferences (e.g. AAS). This allows direct interactions with even larger groups of educators and mentors from all over the world, not only to let them know about our efforts, but also to get responses back from them. Sending booths filled with GLAST curriculum materials and expert staff is an important part of our effort to expand the scope of our E/PO activities into the formal and informal education communities. The education booth (jointly sponsored with the Swift and XMM-Newton E/PO programs) typically travels to 4-6 conferences per year, while the GLAST science booth typically travels to 2 or 3 meetings per year.

Teacher training workshops are the main role of the GSFC partnership, under the direction of LHEA E/PO lead Dr. Jim Lochner. The first was held in 2001 as part of the Gamma 2001 conference in Baltimore Maryland. The second was held in 2004 in conjunction with the High Energy Astrophysics Meeting in New Orleans, and another is planned for 2006. These workshops are held in conjunction with scientific conferences, and typically reach about 40 high-school teachers, for one to two days of presentations. The content matter in these workshops has evolved from a narrow emphasis on gamma-ray science content to a more general “short-course” entitled *Modeling the Universe* (MTU) that uses some GLAST E/PO materials. MTU was developed by several contributing missions under the auspices of the SEU Forum. MTU was most recently presented in conjunction with the January 2005 AAS meeting in San Diego, sponsored by GLAST and organized by SSU personnel (Sarah Silva). Special efforts are made to reach teachers from schools with under-represented populations.

GLAST also supports workshops for amateur astronomers and educators in conjunction with the American Association of Variable Star Observers (AAVSO) through the GBM E/PO program based at MSFC. The first was held in the summer of 2002 in Hawaii; the second was held in the spring of 2005 in New Mexico, and specifically targeted local Native American teachers. It also included a special lecture for the general public by SSU E/PO team member Dr. Phil Plait. Presentations by GLAST team members about Active Galaxies, gamma-ray bursts, and other scientific targets of mutual interest have been given. The AAVSO members are major partners in the Global (formerly GLAST) Telescope Network (see 1.9).

1.4 NASA QUEST Space Scientist Web Chats - suspended

GLAST science team members regularly participated in NASA QUEST's ongoing Space Scientist Online program during 2000-2001. Web chats featuring GLAST scientists were organized and moderated by Cominsky and Plait. Space Scientists Online is a partnership between the NASA Ames Research Center QUEST project and NASA OSS to provide the educational community with new and exciting information from space sciences, as well as collecting relevant information from previous space science projects. Classrooms of students and teachers sign up to hear project news via live web chats, and read biographical information and field journals from the scientists involved. Swift and GLAST scientists shared the "expert" responsibilities for the web chats, which occurred once each month during the academic year, at a regularly scheduled time. These chats are now archived on the GLAST web site (<http://glast.sonoma.edu/chats/index.html>). Attendance was low, and QUEST changed their policy to require substantial payments in order to continue our participation. After evaluating the impact of these chats, we decided to suspend this part of our program.

1.5 SLAC's Virtual Visitor Center: Interactive gamma-ray detector exhibit

Dr. Helen Quinn directs a project that is a component of the SLAC Virtual Visitor Center (VVC) that facilitates web-based interactive opportunities to allow users to develop their understanding of particles and their interactions (Physical Science Content Standard B for grades 9-12). The website is targeted for use in formal education settings, and is grade-appropriate for physics students at the high school and community college level. However, it also encourages informal exploration by the public. This section of the VVC includes an area in which users can run a simulation program to study the interactions of photons (gamma-rays) and electrons with matter, and to view the output via the World Wide Web. Working with Dr. Richard Dubois at SLAC, SSU staff are extending this website to include an interactive simulator of the GLAST Large Area Telescope (LAT) detector, which uses the project's simulation code to model the conversion of gamma-ray photons into electron-positron pairs and their tracks through the detector planes into the calorimeter. All the new web pages are being designed and implemented at SSU, including the LAT simulations, and will be ported to SLAC VVC site after testing by the EAs and approval by the project. This is in progress in June 2005 and is expected to be in beta-test by September 2005.

1.6 PBS/NOVA Television Program

Thomas Lucas Productions is negotiating a contract with PBS/NOVA in order to develop a one-hour program that focuses on black holes. Tentatively entitled "Black Holes: the Other Side of Infinity", the show includes high-definition (HD) simulations, and scientists discussing the black hole in the center of the Milky Way, and black holes and jets in the high-energy universe. NASA funds were used as seed money to begin this process. In the fall of 2002, Lucas led a successful proposal effort that obtained over a million dollars from NSF to develop HD graphics and simulations, to augment the website development by PBS/NOVA staff, and to develop a large format planetarium show and other printed educational materials in partnership with the Denver Museum of Nature and Science. Thomas Lucas Productions has extensive experience in developing astronomy shows for public television: they produced *Mysteries of Deep Space* (which featured the Hubble Space Telescope), *Voyage to the Milky Way*, and the NSF-co-

sponsored documentary *Runaway Universe* (which is about dark energy and the cosmological constant). Cominsky is the scientific director for this project, and the Advisory board also includes GLAST scientist David Thompson (GSFC) as well as Harvey Tananbaum (Chandra X-ray Center Director, CfA) and Roger Blandford (Director, Kavli Institute for Particle Astrophysics and Cosmology, Stanford.) The planetarium show is scheduled to premiere in late 2005 or early 2006, and the NOVA program should air in mid-2006.

1.7 GLAST Video

The GLAST video was produced in 2002 by Mike Zeko with scientific support from Cominsky and Jerry Bonnell (GSFC). The video includes animations and graphics, is easily distributed on either a CD or downloadable from the Internet (http://glast.sonoma.edu/resources/multimedia/glast_movie.html) and introduces the high-energy gamma-ray sky, explaining the scientific motivations for GLAST. In compliance with Code 508, closed-captioning has now been added to the Internet version of the video. The video has been provided to the Cosmic Questions museum exhibit, and is also distributed widely to educators as part of the SpacePlace lending library. Science team members who are giving public presentations about GLAST also frequently use it.

1.8 Global Telescope Network

The Global Telescope Network (GTN) is an association of professional and amateur astronomers using small telescopes who have agreed to work together to obtain ground-based data in support of the scientific objectives of the GLAST, Swift and XMM-Newton missions. Further information is given at the GTN website (<http://gtn.sonoma.edu>).

In support of the GTN, SSU purchased a remotely-controlled and operable 14-inch telescope mounted on a computer controlled Paramount and equipped with a high quantum efficiency CCD detector and filter wheel. The telescope, nicknamed GORT (GLAST Optical Robotic Telescope) is located at the Pepperwood Preserve in northern Sonoma County, and is now completely operational from remote locations. This site is owned and operated by the California Academy of Sciences, and we have entered into a partnership with them to provide public access to the telescope, to the GLAST-oriented observations, and to produce public observing nights several times during each year.

The GTN is managed by SSU Astronomy Professor Gordon Spear, and the installation of the telescope and development of archival and web-based control software is the responsibility of SSU Instructional Technology Expert Timothy Graves. Testing of the equipment (pointing abilities, data acquisition, calibration, and analysis) is being done by Spear, Graves, Plait, and SSU physics and astronomy students.

GLAST provides partial support for GSFC personnel who support the Gamma-ray Coordinates Network (GCN), as part of an effort to link non-professional observers at telescopes worldwide who are interested in tracking gamma-ray bursts and their afterglows. We also maintain a formal partnership with the American Association of Variable Star Observers (AAVSO) to obtain data on Active Galaxies, and gamma-ray bursts. In this latter effort, the AAVSO also partners with Marshall Space Flight Center personnel involved with the GLAST GBM E/PO effort (under the direction of Dr. Chryssa Kouveliotou). Many members of the AAVSO attend the MSFC training workshops (see above, section 1.3). The founding members of the GTN also include the Elk Creek Observatory 20-inch telescope (Holton, Kansas High School, home of Educator

Ambassador Mike Ford) and Western Kentucky University's 24-inch Bell telescope (under the direction of Prof. Michael Carini.)

Now that GORT is online, the GTN has been actively signing up new members as both associates (who use our telescope) and partners (who provide their own telescopes and monitor GTN program objects.) As of June 2005, we have new international partners or associates at: Agrupacion Astronomica de Sabadell (Barcelona, Spain), Tonantzintla Observatory (Tonantzintla, Mexico), Group of Relativistic Astrophysics and Radioastronomy, Universidad Nacional de La Plata (Buenos Aires, Argentina), Bernard Heathcote (Victoria, Australia), Carnes Hill Observatory (Sydney, Australia), and Instituto Copernico (Mendoza, Argentina).

1.9 UC Santa Cruz Outreach Program

The GLAST E/PO program sponsors outreach activities coordinated by the Santa Cruz Institute of Particle Physics (SCIPP), under the direction of GLAST team member Dr. Hartmut Sadrozinski. SCIPP has a long standing program that tours many local schools, entertaining, engaging and educating the students and their teachers with the Tesla Coil Show (<http://scipp.ucsc.edu/outreach/teslacoil/>). Many of these schools have high populations of underrepresented students. They also sponsor a program in which high school teachers and their students learn to use balloons to perform scientific experiments: this program culminates each year with a weekend retreat to a farm in Yolo county, in which the balloons are launched. Several of these high school teachers also accompanied GLAST scientists to the National Balloon Launching Facility at Palestine, Texas, for the launch of the GLAST tower prototype experiment by a high-altitude balloon. (<http://scipp.ucsc.edu/outreach/balloon/index.html>)

2. Evaluation and Assessment

WestEd is responsible for the formal program evaluation and guidance of the GLAST E/PO program. WestEd also works with SSU on evaluating the Swift and XMM-Newton E/PO programs. Led by Dr. Edward Britton, WestEd conducts independent formative and summative evaluations on a regular basis using professionally accepted qualitative and quantitative assessment tools such as questionnaires, telephone interviews, and focus groups. For GLAST, evaluation occurs not only of the training of the Educator Ambassador teachers, workshops conducted by the EAs, their classroom usage and student learning outcomes, but also includes similar metrics for the teachers and students at the second level, i.e., those who are trained by the Ambassadors through educator workshops. Assessment includes each individual part of the GLAST E/PO program as well as measuring the overall effectiveness of the parts working together to quantify the true impact of our efforts in the education and general public communities. The GLAST E/PO website is also evaluated regularly. The results of the evaluations are submitted to the GLAST E/PO Lead Cominsky, who reports all evaluation results regularly to the GLAST program and project management, and to NASA HQ. See Table 2 for details of the past, current, and future evaluation schedule.

The E/PO program described here has many milestones, which allows for easy metric evaluation by the E/PO team and the overall NASA education program. For example, we have Level 4 milestones for the creation and evaluation of individual TOPS curriculum modules, the Space Mystery modules and the PBS show. These provide quantifiable mission metrics. In addition, the efforts from GLAST are routinely being coordinated with those of Swift, and more recently with XMM-Newton. (SSU took over the E/PO program for XMM in 2003.) Having WestEd evaluate

all three programs ensures that a large added value will be achieved, and that efforts are coordinated.

3. Dissemination of Materials/Impact of E/PO program

Dissemination of GLAST materials takes place via a large number of avenues. These include, but are not limited to, access through: workshops and exhibits at national, regional, state, and local teachers meetings; the GLAST E/PO website; the NASA SMD Support Network (i.e., Forums and Broker-Facilitators); NASA CORE; the Imagine the Universe! Website and the TOPS Learning Systems website, marketing, and catalog. In the near future, we also expect to have a presence on the websites of PBS, the Denver Museum of Nature and Science, and the California Academy of Sciences.

The impact and effectiveness of our dissemination will be measured and evaluated by WestEd as part of their assessment process. Results from their studies will be used to guide the GLAST E/PO program as it develops over its multi-year lifetime. We have documented that through the workshops given by E/PO team members and by the Educator Ambassadors, over a thousand teachers a year have received hands-on training with our materials. This will allow the materials to be used by over 100,000 students each year. Added to the educators that will find our materials by other means (such as on the Web), we will be able to get information about gamma-ray astronomy and GLAST science into large numbers of classrooms across the country. In this way, educators will be able to teach about energy, matter, the electromagnetic spectrum, and more with exciting, cutting-edge materials. Dissemination information to teachers, students and the public is regularly reported to the NASA EDCATS system, and all GLAST products are entered into the Space Science Education Research Directory (<http://teachspace.science.org>).

The GLAST telescope network project is engaging both high school students and amateur astronomers, increasing the excitement about GLAST science in the years leading up to the launch. Amateurs outnumber professional astronomers by about 10 to 1, and provide an especially effective avenue of dissemination, through their frequent interactions with civic groups, astronomy clubs, and teacher groups in their home communities.

High leverage activities planned for the GLAST E/PO program include the planetarium show at the Denver Museum of Nature and Science, and the PBS/NOVA program. The planetarium show will be marketed by Spitz, Inc. A typical planetarium show is seen by at least 10,000 people per year and there are over 100 planetaria in North America. PBS/NOVA television programs are viewed by audiences that number in the tens of millions. These types of large leverage, informal education activities provide excellent ways to reach the “attentive public,” and will contribute to our efforts to raise the general level of scientific literacy.

4. GLAST E/PO Management

The GLAST E/PO Organization is shown in Figure 1. The GLAST Large Area Telescope PI, Prof. Peter Michelson, has the responsibility for guiding the LAT portion of the mission, which contractually includes the funding for E/PO activities. As a facility-class mission, however, the GLAST E/PO program is also obligated to represent the GLAST Burst Monitor, and spacecraft and launch support. GLAST Project Manager Kevin Grady has asked Deputy Project Scientist Dr. Neil Gehrels to oversee the GLAST E/PO program for the entire mission. Dr. Gehrels is fully committed to E/PO and 1) provides oversight on the E/PO program to ensure that all E/PO

products are scientifically accurate and technically correct; 2) ensures that all E/PO activities are consistent with the scientific and technological goals of the mission; and 3) participates personally in the E/PO program through local presentations and public outreach efforts.

The SSU E/PO budget is managed as a sub-system through the GLAST LAT Project Management Control System (PMCS) at Stanford University. Each month, we report our actual costs of work performed (ACWP) in each WBS category, reconcile budget status and provide narrative progress reports to the GLAST LAT Project management at Stanford. Changes to the E/PO program and budget are handled by the project's CCB process. Further details of the WBS for the E/PO program can be provided upon request (including the budget model for PMCS). The GSFC E/PO budget is managed by Dr. Neil Gehrels, and is not included in the PMCS system.

At Sonoma State University, E/PO lead and science Co-I Prof. Lynn Cominsky oversees the E/PO program under the direct supervision of Deputy Project Scientist Gehrels. Prof. Cominsky 1) provides a focused direction for the SSU team; 2) coordinates all E/PO activities with all participants, including the mission science, SSU team, and all E/PO partners, the Science Mission Directorate E/PO, and the NASA Office of Education and the external evaluators at WestEd; 3) ensures that the mission science will be combined with innovative learning ideas and aligned with national science and mathematics standards; 4) represents the E/PO group at all science team management meetings and reviews; and 5) provides lead work direction to the Educational Resource Director (Dr. Phil Plait), Program Manager (Sarah Silva) and the GTN Director (Prof. Gordon Spear.)

The E/PO Program Manager Sarah Silva 1) manages the GLAST E/PO program on a daily basis, coordinating all programs and activities under the direction of the E/PO lead. She 1) supervises the other SSU E/PO staff including the Instructional Technology Expert, the Scientific Illustrator, and the Project and Student Assistants; 2) is responsible for originating and tracking all budgets, subcontractor contracts and schedules; 3) directs the Educator Ambassadors program; 4) contributes to the design and development of educational products and workshops for both students and teachers; and 5) is the main point of contact for the Science Mission Directorate Support Network, ensuring GLAST participation in a wide variety of multi-mission activities.

The Education Resource Director, Dr. Phil Plait, is primarily responsible for science content development, having authored both the E/PO website content and the Active Galaxies Educator Unit. He is responsible for ensuring standards alignment for the science and mathematics areas. He has also contributed to the other written materials including brochures and magazine articles. He represents the project at management meetings if Prof. Cominsky is unavailable, and also conducts workshops for both students and teachers.

The Global Telescope Network Director Dr. Gordon Spear is responsible for coordinating the efforts of the associates and partners who have signed up to take data for the GTN. This includes determining the observing schedules and target selections for partners, and organizing campaigns to monitor specific targets of interest to GLAST science.

The Instructional Technology Expert, Tim Graves, is responsible for the construction, development, and routine operation of the SSU Pepperwood telescope. He is developing the data

archiving system for GTN data, and GTN communications protocols. He also oversees the maintenance and support of all GLAST E/PO computer and server equipment.

Scientific Illustrator Aurore Simonnet is responsible for the design and layout of all graphical components of the GLAST E/PO materials. She created the Active Galaxies poster, and has done layout and illustration for the Active Galaxies education unit, various brochures, the GLAST sticker, the GLAST magic cube, graphics for the web site, and all other printed materials. Recently, she has originated the concepts and designed the Active Galaxies pop-up book and the GLAST Race Card game.

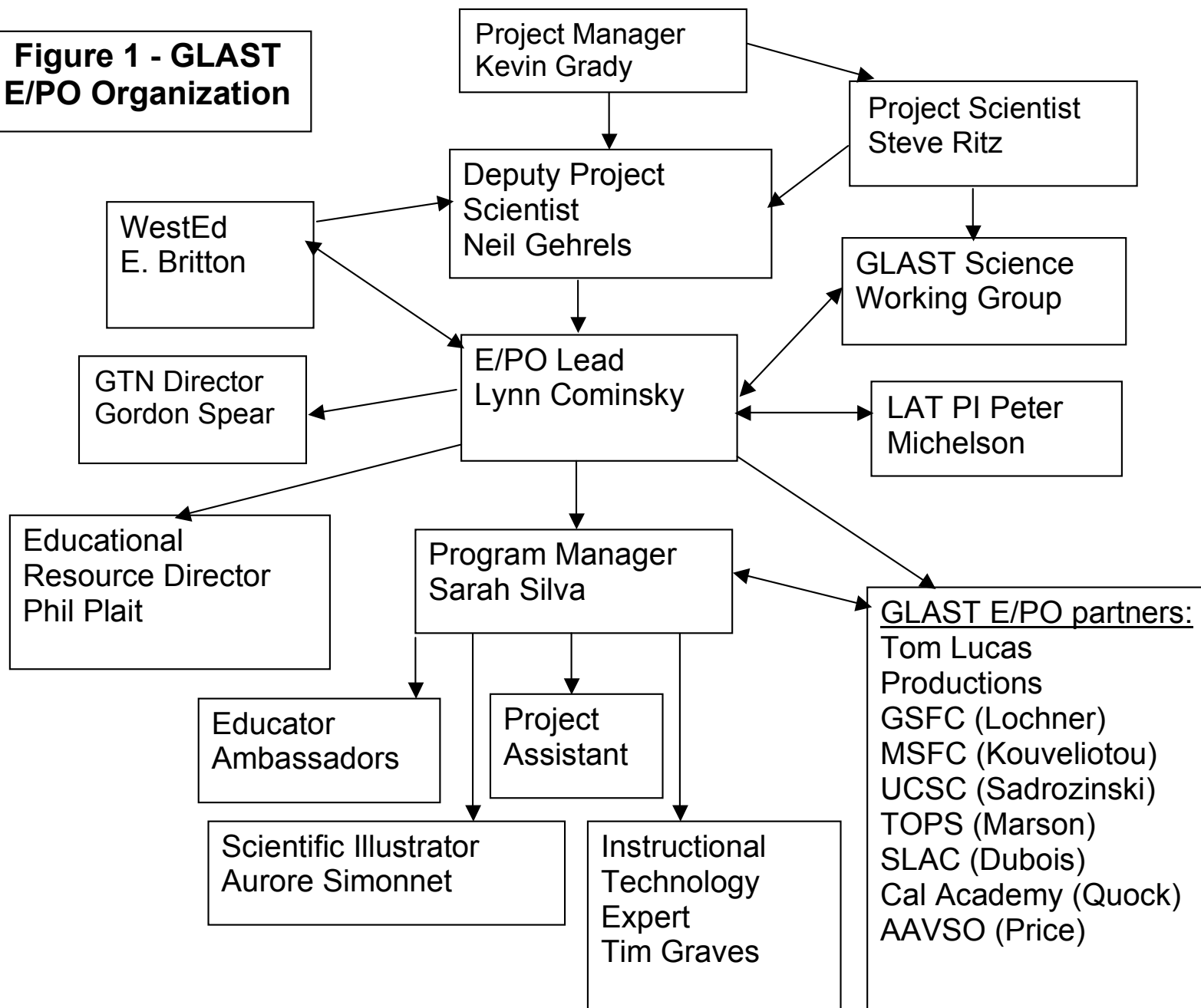
The SSU group also employs a project assistant and student assistants to perform general office administration, including regular mailing to the Educator Ambassadors and E/PO network, general web administration and upkeep, ordering and receiving E/PO materials and other communications tasks.

The GLAST Science Working Group, under the direction of Project Scientist Dr. Steve Ritz is committed to providing oversight and input to the E/PO effort for GLAST, ensuring the accuracy in the materials' content. SWG members also speak to students and the public, and provide input into the design of the E/PO products. The GLAST E/PO program is regularly reviewed by the SWG, and all printed and web-based materials are sent to the SWG for technical review. For a complete list of the SWG members, see <http://glast.gsfc.nasa.gov/science/swg/members.html>.

Sonoma State University (SSU), as the lead institution for GLAST E/PO, subcontracts work to different program elements including: Goddard Space Flight Center (Dr. Jim Lochner), Marshall Space Flight Center (Dr. Chryssa Kouveliotou), UC Santa Cruz (Dr. Hartmut Sadrozinski), SLAC (Dr. Richard Dubois), TOPS Learning Systems (Ron Marson), Thomas Lucas Productions (Tom Lucas), the California Academy of Sciences (Bing Quock) and the American Association of Variable Star Observers (Aaron Price). Statements of work and technical oversight for these subcontractors are the responsibility of Dr. Lynn Cominsky, while daily oversight, budget, and schedule tracking are performed by Sarah Silva.

External evaluation of the program is performed by WestEd, under the direction of Dr. Edward Britton. WestEd employs specialists in evaluating content in science, mathematics, technology, web site design and teacher training, and conducts implementation, formative and summative reviews of the GLAST E/PO program.

**Figure 1 - GLAST
E/PO Organization**



	<u>Table 1 – GLAST E/PO Goals</u>	How do galaxies, stars, and planetary systems form and evolve?	What happens to space, time and matter at the edge of a black hole?	What are the cycles of matter & energy in the evolving universe?	
Science Goals	E/PO Goals	Universe Division Goals			Program Components
How do active galactic nuclei (AGN) form and evolve?	Use Active Galaxies as an engagement to teach basic principles in physical science and math for grades 9-12	X	X	X	1.1, 1.2 1.3, 1.8
What is the nature of jets emanating from AGNs and Galactic black holes?	Use the mystery of jets coming out of black holes to inform and excite students and the public, and to teach about the properties of gamma-ray light		X	X	1.1, 1.2 1.3, 1.6 1.7, 1.9
What is the origin of the isotropic "diffuse" gamma-ray background?	Facilitate understanding of the physical properties of different wavelengths of light and how scientists use light to study the Universe.	X		X	1.3, 1.5 1.7, 1.8 1.9
What are the sites and mechanisms of cosmic-ray acceleration?	Use observations of supernova remnants as an engagement to teach students about the relationship between the acceleration of charged particles and the creation of high-energy light			X	1.1 1.2 1.3
What are gamma-ray bursts and how do they generate high-energy radiation?	Use GRBs as an engagement to teach students about the electromagnetic spectrum, as well as the interactions between energy and matter	X	X	X	1.3 1.8
What are the unidentified high-energy gamma-ray sources?	Use the map of the gamma-ray sky to illustrate the diversity of objects in the high-energy Universe, compare them to the visible sky and teach about the properties of different energies of light	X		X	1.1, 1.3 1.7, 1.8
Is it possible to detect any signatures of galactic dark matter?	Facilitate understanding of the different components that make up the Universe and how they form and evolve	X		X	1.1 1.3 1.6
How do rotation-powered pulsars generate high-energy gamma-rays?	Use pulsars as an engagement to teach about magnetic fields and magnetism	X		X	1.2 1.3

Table 2 – GLAST Evaluation Schedule

WestEd will conduct any or all of the following evaluation tasks for SSU-developed or SSU-sponsored classroom resources:

- (i) Arrange and observe field-testing,
- (ii) Arrange discussion via teleconferencing between SSU and teacher evaluators
- (iii) Expert appraisal of instructional design features as part of formative review.

These evaluation tasks will focus on the following materials:

E/PO Program Element	Material to be evaluated	Evaluator's Tasks
Fiscal Year 06		
1.2	GLAST AGN Pop-up Book	(i)
1.6	GLAST Black Hole Products	(i), (ii), (iii)
1.3	CSTA Annual Meeting (TOPS and AGN)	(iii)
1.3	Educator Ambassador Program (summative)	(i), (iii)
Fiscal Year 05		
1.2	TOPS III Activity set	(i), (ii), (iii)
1.1	Space Mysteries II & III (one unit) continue	(i), (ii), (iii)
1.5	SLAC Website	(iii)
1.8	AAVSO HEA Meeting Evaluation	Create a formative assessment tool for meeting.
1.2	XMM-Newton and GLAST Supernova Educator Unit	(i), (ii), (iii)
1.3	Educator Ambassador Program and workshop follow-up (formative)	(i)
Fiscal Year 04		
	TOPS II Activity set	(i), (ii), (iii)
1.3	Educator Ambassador Program (formative)	(i), (iii)
Fiscal Year 03		
1.2	Active Galaxy Educator Unit	(i), (ii), (iii)
1.2	TOPS I Activity set	(i), (ii), (iii)
1.1	GLAST E/PO website at SSU	(iii)
1.3	NSTA Annual National Meeting (TOPS)	Effectiveness of materials dissemination
1.3	NCTM Annual National Meeting (TOPS)	Effectiveness of materials dissemination
Fiscal Year 02		
1.2 & 1.3	GLAST ambassador and materials	(i), (iii)
1.3	Ambassador Training	(i), (iii)